COST-BENEFIT ANALYSIS AND ENVIRONMENTAL IMPACT BY USING COMBINED RENEWABLE RESOURCES IN THE PRODUCTION OF 10 MW OF ELECTRICITY

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ABSTRACT

The aim of the paper is to analyze the two components of renewable energy - the sun and the wind to support a transition to a climate-friendly society, based on sustainable energy supply and consumption, which minimizes the negative effects on natural resources, environment, climate and human health, being both economically feasible and socially acceptable. The paper will analyze the production of 10MW electricity using wind and sun as renewable resources. The study area is Moldova Noua, Romania. The RETScreen Expert software will be used for the analysis.

INTRODUCTION

Wind energy is one of the energy sources that provides the smallest climate footprint. At the same time, the wind is a renewable natural resource that does not run out. By replacing energy sources such as coal, oil and biogas with wind energy, we can reduce greenhouse gas emissions for the benefit of the climate. [1] Wind turbines use wind to produce energy and are a proven technique for producing renewable energy. According to research, wind energy is a very efficient and gentle form of renewable energy. Renewable energy is a common term for forms of energy that have unlimited resources. Sun and wind are always available. The renewable energy sources for which we have the best user experience are wind and solar energy. What they have in common is that they have a very small climate footprint and put pressure on terrestrial resources only to a very limited extent. Globally, wind turbines today supply almost 600,000 MW of fuel-free electricity. [2] The aquaculture industry is one of the fastest growing industries in the world, as population growth requires higher fish production. It is necessary for the production of fish in aquaculture to take place in a sustainable way, so through this paper we aim to analyze the production of 10 MW of electricity in the area of Moldova Nouă, using wind turbines, to be used in fish farms. The results obtained will be compared with the results obtained by producing 10 MW using photovoltaic panels. The analysis will follow both the environmental impact and the financial aspects, respectively the investment recovery period.

MATERIAL AND METHOD

The energy that wind turbines can take out of the wind depends a lot on the surrounding terrain. If the area is very hilly or there are many buildings, the direction and power of the wind are affected and therefore the effect that the wind turbine can take out of the wind. [2] By assembling wind turbines in wind farms, the investment is a bit cheaper, as the turbines can share transformers and cables to operate. In addition, it is also an advantage that wind turbines are located together, an advantage in their maintenance and repair.

The energy (E) in the air per unit time passing through an imaginary surface A is given by the expression: [4]

$$E = ½\, m \cdot v^2 = ½\, (A \cdot v \cdot \rho) \cdot v^2 = ½\, A \cdot \rho \cdot v^3 \quad (1)$$

Where m is the mass of air passing over the surface A and ρ is the density of air, which is normally 1.23 kg / m^3. The energy per unit time is the same as the power (P), and the wind power that passes over an imaginary area, calculated per unit area, then becomes:

$$P = ½\, \rho \cdot v^3 \ [W / m^2] \quad (2)$$

The wind power in an open air stream thus becomes proportional to the wind speed at the third power. [4]

Table1

Wind energy depending on wind speed	
Wind speed (m/s)	The power of the wind (W/m^2)
4	39
6	133
8	315
10	615
12	1063
15	2076
25	9609

The wind range shown in Table 1 reflects the fact that most wind turbines depend on wind speed, at least a light breeze before they can start, and that they are designed to be stopped when the wind exceeds a complete storm. [4] For modeling we used Virtual energy analyzer, a virtual analyzer of the proposed project feasibility, from RetScreen Expert.[5]

Figure 1 shows the study area, respectively Moldova Nouă. Through this paper we want to know if it is feasible to propose a project to produce 10MW of electricity using wind turbines.

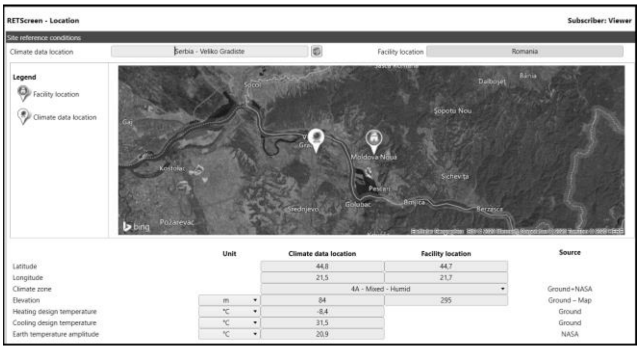

Figure 1 - Location of the study area

By choosing the study area and using the virtual analyzer, the program connects us to the nearest database, Veliko Gradiste, Serbia, where we are provided with climate data from Figure 2.

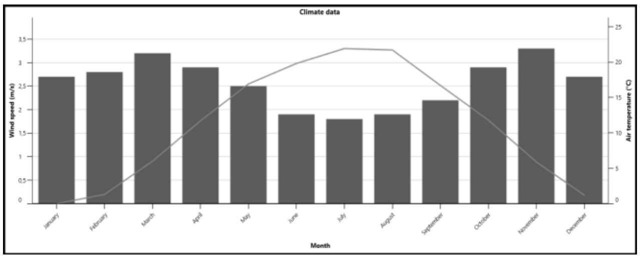

Figure 2 - Climatic data, respectively wind variation during a year, in the study area

Figure 3 - Input data

Figure 3 shows the input data, respectively the production of 10 MW of electricity using wind turbines. Figure 4 shows the types of turbines used, depending on wind speed, investment costs and recovery period. We have five types of turbines, for wind speeds of 1.6 m/s, 2.6 m/s, 3.6 m/s, 4.6 m/s and 5.6 m/s. All have an initial cost of $ 25 million, and produce different amounts of energy, with a different payback period.

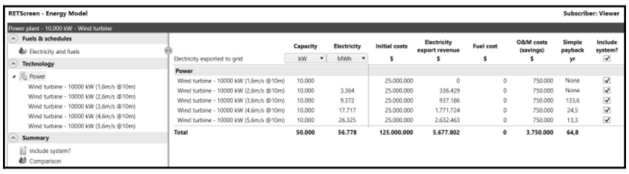

Figure 4 - Shows the types of turbines used

Among the types of turbines proposed by the system, we will analyze the turbines that produce 10 MW of electricity using a wind speed of 3.6 m/s, because they are closest to the wind speed in the study area, respectively 2.6 m/s, the result from climate data.

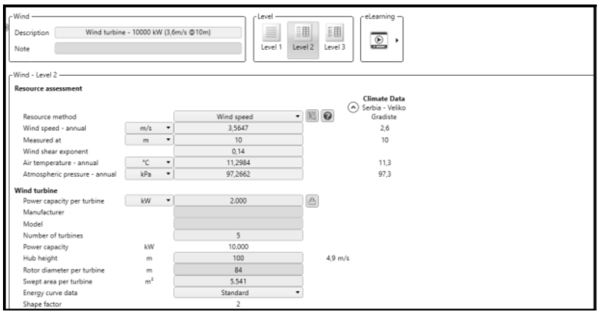

Figure 5 - Characteristic data of the chosen system

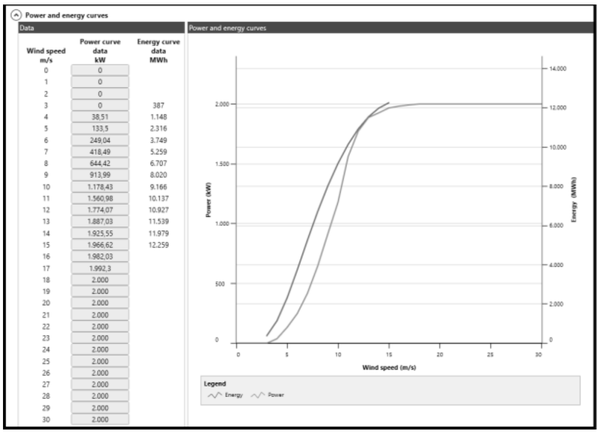

Figure 6 - Energy produced as a function of wind speed

Figure 6 shows the graph of energy production as a function of wind speed. Figure 7 shows the initial and operating costs, in canadian dollars, set by the virtual analyzer. For the system proposed by us the capacity factor is 10.7%

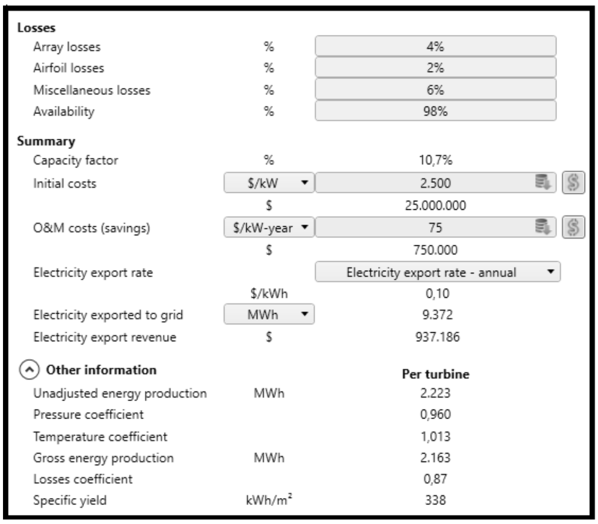

Figure 7- Initial and operating costs

The impact on the environment of the analyzed system, respectively the cost-benefit analysis will be presented in the results section.

RESULTS AND DISCUSSIONS

Climate problems are becoming more and more important today. Part of the solution to this global challenge is wind energy, which is largely pollution-free and has enormous growth potential. Last but not least, wind energy is renewable.

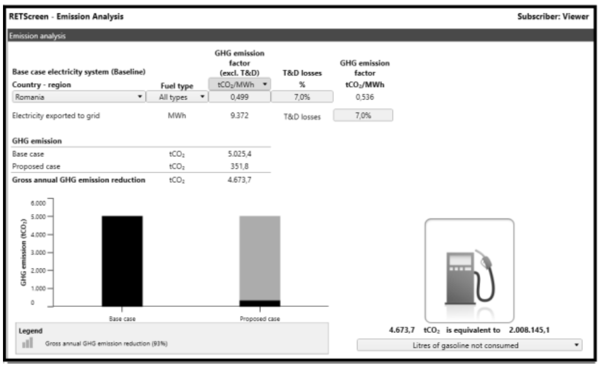

Figure 8 - Environmental impact

As can be seen from Figure 8, the proposed case has an important impact on the environment, by reducing the amount of CO_2 by 4,673 tCO_2, compared to an initial case in which fossil coal would be used.

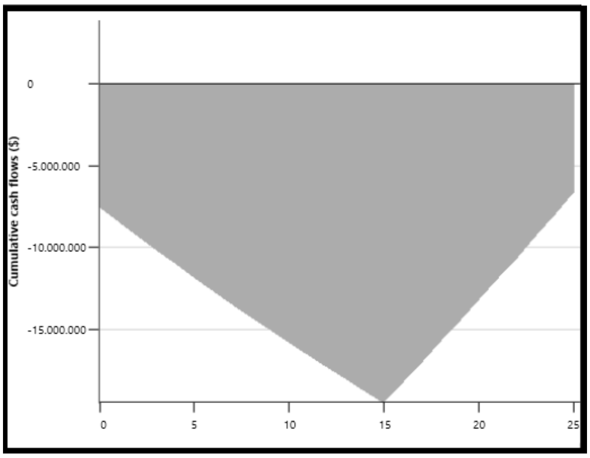

Figure 9 - Return on investment over a period of 25 years

As can be seen from Figure 9, the system proposed to produce 10MW of electricity using 3.6 m/s wind turbines in the Moldova Noua area is not recovering in 25 years. If we used turbines of 4.6 m/s and 5.6 m/s, respectively, the recovery period would be 24 years and 13 years, respectively, but the wind speed in the study area does not favor the use of these turbines.

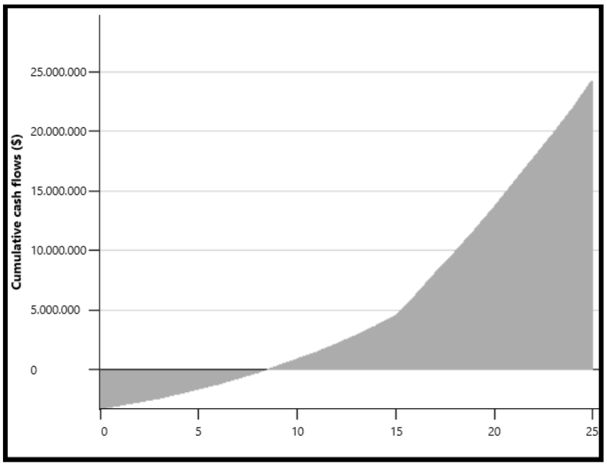

Figure 10 - Return on investment using photovoltaic panels[5]

Figure 10 shows the investment recovery period for the study area, for the production of 10MW of electricity using photovoltaic panels. Analyzing the two graphs regarding the cost - benefit analysis, we can say that the use of photovoltaic panels to produce 10MW of electricity in the Moldova Noua plant is more feasible compared to the use of wind turbines.

CONCLUSIONS

Wind turbine technology is being developed, but there are some challenges that need to be addressed if we look at wind turbines as the main form of production in electricity supply. An obvious problem is that wind turbines do not produce electricity when we do not have wind. At present, it is not possible to store electricity without major energy losses or economic losses. Therefore, there are situations where there is not enough wind to cover electricity consumption and, conversely, there are situations where more electricity is produced on wind turbines than is used.

Another challenge for wind turbines is that rapid wind changes give small variations in the power that the wind turbine produces. For security of supply to be intact, there must always be a balance between consumption and production. This means that if there is a strong gust of wind more power will be produced in a short time, so in order for there to be a balance it is necessary that an appropriate amount of energy is used. In the paper, as can be seen, on the investment side, in the production of energy using wind turbines, the amount introduced is not recovered if we take into account the climatic conditions in the area. In the EU area, by 2040, 30% of energy consumption is expected to be covered by wind energy.

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